

CLAIMS

1. A process for producing a catalyst for the production of acetic acid, the catalyst being a supported catalyst which is used in a process for producing acetic acid by reacting ethylene and oxygen in a gas phase and comprises (a) palladium and (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, the process comprising loading palladium in parts and through at least two steps.
2. The process for producing a catalyst for the production of acetic acid as claimed in claim 1, which comprises the following first and second steps:
- First Step:
- a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;
- Second Step:
- a step of loading (a) palladium and (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof on the palladium-supported catalyst obtained in the first step to obtain a catalyst for the production of acetic acid.
3. A process for producing a catalyst for the production of acetic acid, the catalyst being a supported catalyst which is used in a process for producing acetic acid by reacting ethylene and oxygen in a gas phase and comprises (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te, the process comprising loading palladium in parts and through at least two steps.
4. The process for producing a catalyst for the production of acetic acid as claimed in claim 3, which comprises the following first and second steps:
- First Step:
- a step of loading (a) palladium and (c) at least one element selected from the group consisting of

Sn, Pb, Bi, Sb and Te on a support to obtain a palladium-supported catalyst;

Second Step:

5 a step of loading (a) palladium and (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof on the palladium-supported catalyst containing an element of the group (c) obtained in the first step to obtain a catalyst for the production of acetic acid.

10 5. The process for producing a catalyst for the production of acetic acid as claimed in claim 3, which comprises the following first and second steps:

First Step:

15 a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;

Second Step:

20 a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst obtained in the first step to obtain a catalyst for the production of acetic acid.

25 6. The process for producing a catalyst for the production of acetic acid as claimed in claim 3, which comprises the following first, second and third steps:

First Step:

a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;

30 Second Step:

a step of loading (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst obtained in the first step to obtain a palladium-supported catalyst containing an element of the group (c);

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Third Step:

a step of loading (a) palladium and (b) at

least one compound selected from the group consisting of heteropolyacids and salts thereof on the palladium-supported catalyst containing an element of the group (c) obtained in the second step to obtain a catalyst for the production of acetic acid.

7. A process for producing a catalyst for the production of acetic acid, the catalyst being a supported catalyst which is used in a process for producing acetic acid by reacting ethylene and oxygen in a gas phase and comprises (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn, the process comprising loading palladium in parts and through at least two steps.

8. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first and second steps:

First Step:

a step of loading (a) palladium, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

Second Step:

a step of loading (a) palladium and (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof on the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the first step to obtain a catalyst for the production of acetic acid.

9. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first and second steps:

First Step:

a step of loading (a) palladium and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on a support to obtain a palladium-supported catalyst;

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Second Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on the palladium-supported catalyst containing an element of the group (c) obtained in the first step to obtain a catalyst for the production of acetic acid.

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10. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first and second steps:

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First Step:

a step of loading (a) palladium and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

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Second Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst containing an element of the group (d) obtained in the first step to obtain a catalyst for the production of acetic acid.

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11. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first and second steps:

First Step:

a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;

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Second Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on the palladium-supported catalyst obtained in the first step to obtain a catalyst for the production of acetic acid.

12. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first, second and third steps:

First Step:

a step of loading (a) palladium and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

Second Step:

a step of loading (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst containing an element of the group (d) obtained in the first step to obtain a palladium-supported catalyst containing an element of the group (c) and an element of the group (d);

Third Step:

a step of loading (a) palladium and (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof on the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the second step to obtain a catalyst for the production of acetic acid.

13. The process for producing a catalyst for the production of acetic acid as claimed in claim 7, which comprises the following first, second and third steps:

First Step:

a step of loading (a) palladium on a support to

obtain a palladium-supported catalyst;

Second Step:

5 a step of loading (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst obtained in the first step to obtain a palladium-supported catalyst containing an element of the group (c);

Third Step:

10 a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on the palladium-supported catalyst containing an element of the group (c) obtained in the
15 second step to obtain a catalyst for the production of acetic acid.

14. A process for producing a catalyst for the production of acetic acid, the catalyst being a supported catalyst which is used in a process for producing acetic
20 acid by reacting ethylene and oxygen in a gas phase and comprises (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te, (d) at least
25 one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn and (e) at least one element selected from the group consisting of V and Mo, the process comprising loading palladium in parts and through at least two steps.

30 15. The process for producing a catalyst for the production of acetic acid as claimed in claim 14, which comprises the following first and second steps:

First Step:

35 a step of loading (a) palladium, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn

on a support to obtain a palladium-supported catalyst;

Second Step:

5 a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (e) at least one element selected from the group consisting of V and Mo on the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the first step to obtain a catalyst for the production of acetic acid.

10 16. The process for producing a catalyst for the production of acetic acid as claimed in claim 14, which comprises the following first and second steps:

First Step:

15 a step of loading (a) palladium and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on a support to obtain a palladium-supported catalyst;

Second Step:

20 a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn and (e) at least one element
25 selected from the group consisting of V and Mo on the palladium-supported catalyst containing an element of the group (c) obtained in the first step to obtain a catalyst for the production of acetic acid.

30 17. The process for producing a catalyst for the production of acetic acid as claimed in claim 14, which comprises the following first and second steps:

First Step:

35 a step of loading (a) palladium and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

Second Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (e) at least one element selected from the group consisting of V and Mo on the palladium-supported catalyst containing an element of the group (d) obtained in the first step to obtain a catalyst for the production of acetic acid.

10 18. The process for producing a catalyst for the production of acetic acid as claimed in claim 14, which comprises the following first and second steps:

First Step:

15 a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;

Second Step:

20 a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te, (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn and (e) at least one element selected from the group consisting of V and Mo on the palladium-supported catalyst obtained in the first step to obtain a catalyst for the production of acetic acid.

25 19. The process for producing a catalyst for the production of acetic acid as claimed in claim 14, which comprises the following first, second and third steps:

30 First Step:

 a step of loading (a) palladium and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

35 Second Step:

 a step of loading (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and

Te on the palladium-supported catalyst containing an element of the group (d) obtained in the first step to obtain a palladium-supported catalyst containing an element of the group (c) and an element of the group (d);

5 Third Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof and (e) at least one element selected from the group consisting of V and Mo on
10 the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the second step to obtain a catalyst for the production of acetic acid.

20. The process for producing a catalyst for the
15 production of acetic acid as claimed in claim 14, which comprises the following first, second and third steps:

First Step:

a step of loading (a) palladium on a support to obtain a palladium-supported catalyst;

20 Second Step:

a step of loading (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on the palladium-supported catalyst obtained in the first step to obtain a palladium-supported catalyst
25 containing an element of the group (c);

Third Step:

a step of loading (a) palladium, (b) at least one compound selected from the group consisting of heteropolyacids and salts thereof, (d) at least one
30 element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn and (e) at least one element selected from the group consisting of V and Mo on the palladium-supported catalyst containing an element of the group (c) obtained in the second step to obtain a
35 catalyst for the production of acetic acid.

21. The process for producing a catalyst for the production of acetic acid as claimed in claim 2, 5, 6,

11, 13, 18 or 20, wherein the first step further comprises the following first-1, first-2 and first-3 steps:

First-1 Step:

5 a step of loading (a) a palladium compound on a support to obtain a palladium-supported catalyst;

First-2 Step:

10 a step of dipping the palladium-supported catalyst obtained in the first-1 step in an aqueous alkali solution;

First-3 Step:

a step of reducing the palladium-supported catalyst obtained in the first-2 step to obtain a metal palladium-supported catalyst.

15 22. The process for producing a catalyst for the production of acetic acid as claimed in claim 4, 9 or 16, wherein the first step further comprises the following first-1, first-2 and first-3 steps:

First-1 Step:

20 a step of loading (a) a palladium compound and (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te on a support to obtain a palladium-supported catalyst;

First-2 Step:

25 a step of dipping the palladium-supported catalyst containing an element of the group (c) obtained in the first-1 step in an aqueous alkali solution;

First-3 Step:

30 a step of reducing the palladium-supported catalyst containing an element of the group (c) obtained in the first-2 step to obtain a metal palladium-supported catalyst containing an element of the group (c).

35 23. The process for producing a catalyst for the production of acetic acid as claimed in claim 10, 12, 17 or 19, wherein the first step further comprises the following first-1, first-2 and first-3 steps:

First-1 Step:

a step of loading (a) a palladium compound and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

5 First-2 Step:

a step of dipping the palladium-supported catalyst containing an element of the group (d) obtained in the first-1 step in an aqueous alkali solution;

First-3 Step:

10 a step of reducing the palladium-supported catalyst containing an element of the group (d) obtained in the first-2 step to obtain a metal palladium-supported catalyst containing an element of the group (d).

24. The process for producing a catalyst for the production of acetic acid as claimed in claim 8 or 15, wherein the first step further comprises the following first-1, first-2 and first-3 steps:

First-1 Step:

20 a step of loading (a) a palladium compound, (c) at least one element selected from the group consisting of Sn, Pb, Bi, Sb and Te and (d) at least one element selected from the group consisting of Cr, Mn, Fe, Ru, Co, Cu, Au and Zn on a support to obtain a palladium-supported catalyst;

25 First-2 Step:

a step of dipping the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the first-1 step in an aqueous alkali solution;

30 First-3 Step:

a step of reducing the palladium-supported catalyst containing an element of the group (c) and an element of the group (d) obtained in the first-2 step to obtain a metal palladium-supported catalyst containing an element of the group (c) and an element of the group (d).

25. The process for producing a catalyst for the production of acetic acid as claimed in any one of claims

1 to 24, wherein (b) the heteropolyacid or a salt thereof is selected from the following heteropolyacids and salts thereof:

1-12-phosphotungstic acid: $H_3[PW_{12}O_{40}] \cdot nH_2O$

5 1-12-silicotungstic acid: $H_4[SiW_{12}O_{40}] \cdot nH_2O$

wherein n represents an integer of 0 to 40.

26. A catalyst for the production of acetic acid, which is obtained by the process for producing a catalyst for the production of acetic acid as set forth in any one of claims 1 to 25.

27. A process for producing acetic acid, comprising reacting ethylene and oxygen in a gas phase in the presence of the catalyst for the production of acetic acid as set forth in claim 26 obtained by the process for producing a catalyst for the production of acetic acid.